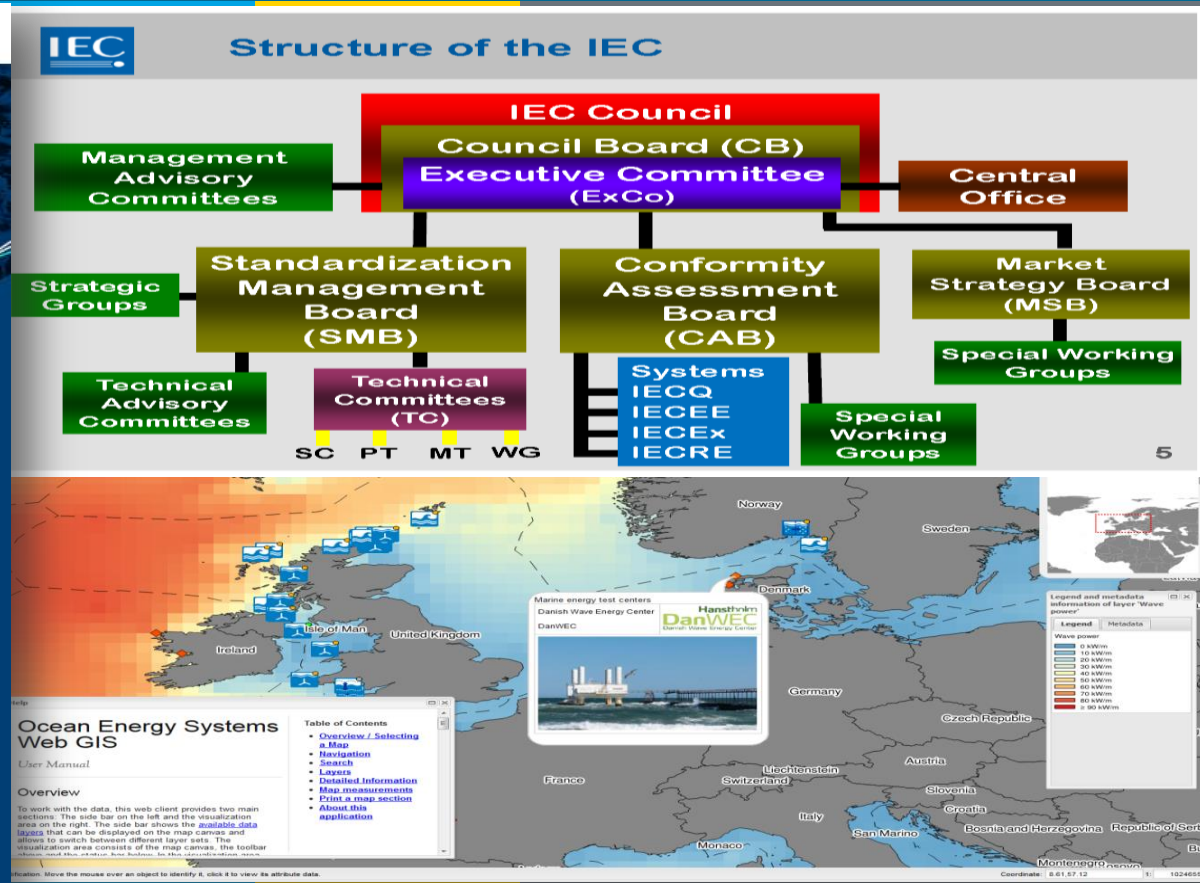
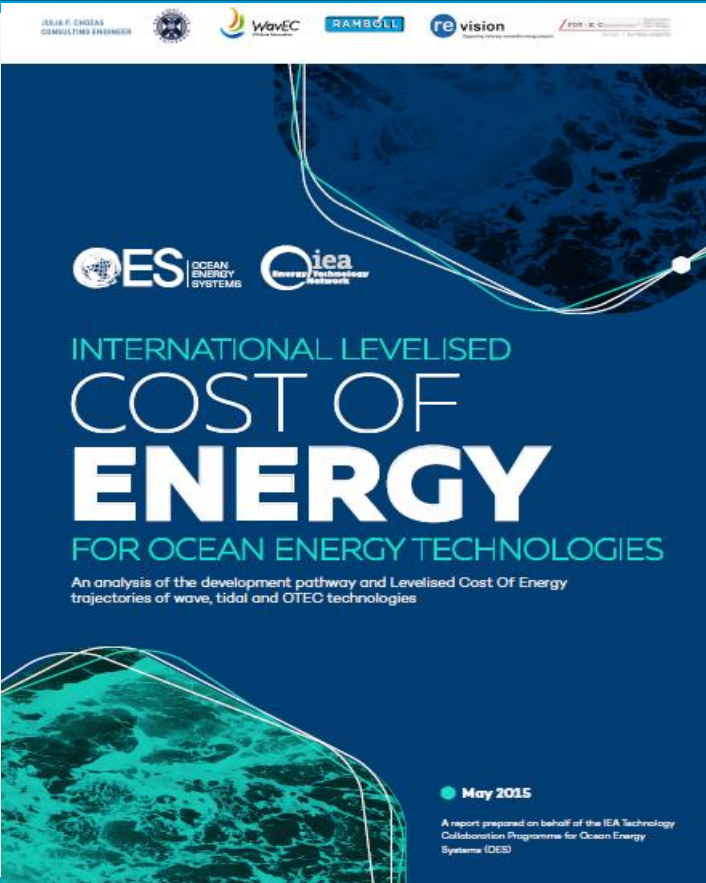


Water Power Technologies Office Peer Review Marine and Hydrokinetics Program

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



Standards Development, IEC TC 114, IEA-OES Annual Contribution

Walt Musial

National Renewable Energy Laboratory
Walter.Musial@nrel.gov 303.384.6956

Standards Development, IEC TC 114, IEA-OES Annual Contribution

- Supports participation in standards development and research programs under International Electrotechnical Commission (IEC) (www.iec.ch) and International Energy Agency (IEA) Ocean Energy Systems (OES) (<https://www.ocean-energy-systems.org/>).
- These are the only activities providing formal international collaboration in DOE program.
- The development of international recognized standards is critical for the commercialization of marine energy technology.
- Nascent industry cannot sustain this activity without DOE support.

The Challenge

- The industry must take aggressive steps to accelerate technology advancement and reduce deployment risk. Internationally recognized standards can help ensure minimum levels of safety, reduce project development risk, secure financing, and provide high-quality reproducible test results.

Partners

- The IEC Technical Committee (TC) 114, U.S. Technical Advisory Group (TAG) has 43 active members from industry, academia, and national labs. In addition, the TAG collaborates with 22 countries participating on this effort.
- The Ocean Energy Systems is an International Energy Agency Technology Collaboration Program that has 25 member countries.

Technology Maturity

- Test and demonstrate prototypes
- Develop cost-effective approaches for installation, grid integration, operations and maintenance
- Conduct R&D for innovative MHK systems & components
- Develop tools to optimize device and array performance and reliability
- Develop and apply quantitative metrics to advance MHK technologies

Deployment Barriers

- Identify potential improvements to regulatory processes and requirements
- Support research focused on retiring or mitigating environmental risks and reducing costs
- Build awareness of MHK technologies
- Ensure MHK interests are considered in coastal and marine planning processes
- Evaluate deployment infrastructure needs and possible approaches to bridge gaps

Market Development

- Support project demonstrations to reduce risk and build investor confidence
- Assess and communicate potential MHK market opportunities, including off-grid and non-electric
- Inform incentives and policy measures
- Develop, maintain and communicate our national strategy
- **Support development of standards**
- Expand MHK technical and research community

Crosscutting Approaches

- Enable access to testing facilities that help accelerate the pace of technology development
- Improve resource characterization to optimize technologies, reduce deployment risks and identify promising markets
- Exchange of data information and expertise

Accelerates MHK Commercialization

Market Development

- Support project demonstrations to reduce risk and build investor confidence
- Assess and communicate potential MHK market opportunities, including off-grid and non-electric
- Inform incentives and policy measures
- Develop, maintain, and communicate our national strategy
- **Support development of standards**
- Expand MHK technical and research community

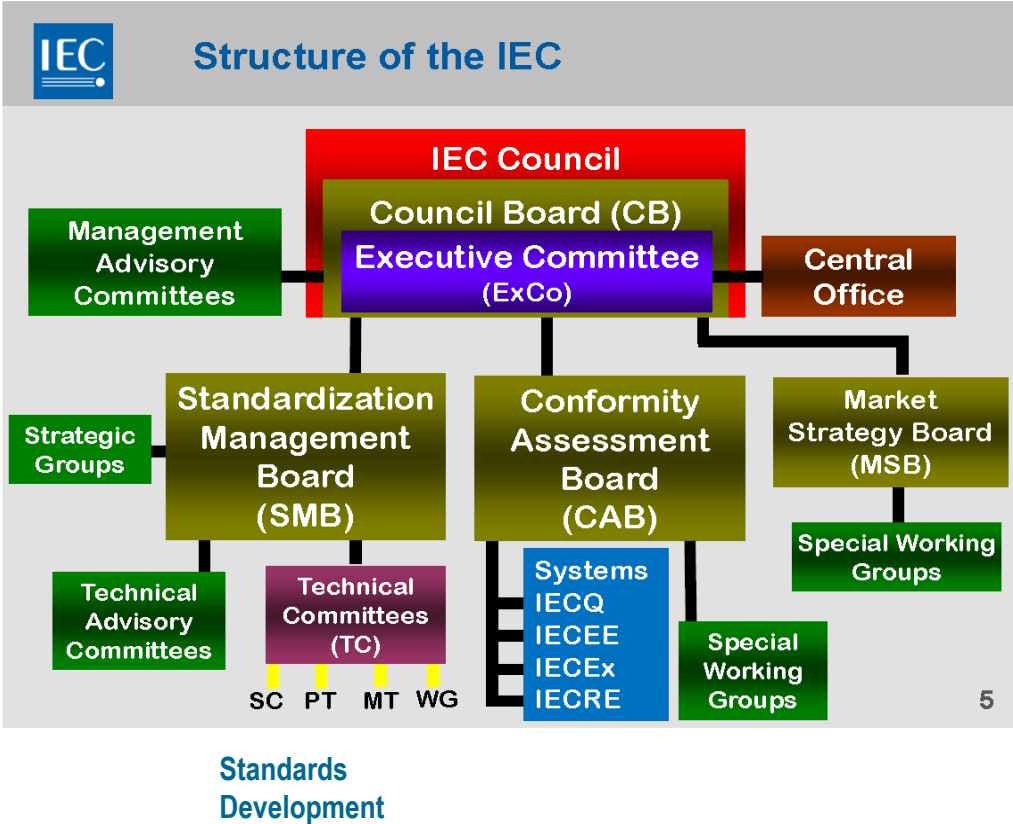
Impact —Internationally recognized consensus standards

- Accelerates commercialization of Marine Energy Technology
- Builds confidence in the investment community for project financing
- Reduces technical risk to developers to enable predictable lifetimes and energy production
- Helps regulators manage risk to public and reduces failures
- Allows U.S. industry to collect critical information and grow through international collaboration
- Enables DOE to construct a targeted and well-informed ocean energy research program
- Provides feedback to the U.S. industry on the status of international activities

Final Product: Mature suite of consensus-based international standards and certification path for commercial development

IEC TC114

- Serve as Technical Administrator to manage U.S. TAG, TC114, and interface with IECRE with American National Standards Institute (ANSI)
- Maintain and manage subcontract (Cardinal Engineering) to support industry participation through stipends and ANSI dues (approx. \$350k)
- Participate and lead directly in the development of international standards and certification processes related to Marine Energy
- Maintain strong international leadership through TC114 chairman, U.S. TC114 Delegation, and TAG Executive Committee



Organizational Structure of IEC

IEC TC114 Project Teams and Ad Hoc Groups



Energy Efficiency & Renewable Energy

Chairman: Neil Rondorf (U.S.; 2011-2016) Jonathan Colby (U.S.; 2016)
 Secretary: Danny Peacock (U.K.)
 Technical Officer: Charles Jacquemart (IEC)

U.S. TA: Jonathan Colby (2014-2016), Bill Staby (2016)
 U.S. Deputy Technical Advisor: Roger Bagbey
 U.S. TAG Administrator: Arielle Cardinal

WG/PT	Title	Convener
MT62600-1	Terminology	Mohamed El-Hawary (CA)
MT62600-2	Design requirements for marine energy systems	Eric Greene (US)
PT62600-20	Guideline for design assessment of Ocean Thermal Energy Conversion (OTEC) system	Martin Brown (GB)
PT62600-30	Electrical power quality requirements for wave, tidal, and other water current energy converters	Mohamed El-Hawary (CA)
PT62600-40	Acoustic characterization of marine energy converters	Brian Polagye (US)
PT62600-102	Wave Energy Converter power performance assessment at a second location using measured assessment data	Kim Nielsen (DK)
PT62600-103	Guidelines for the early-stage development of wave energy converters: Best practices and recommended procedures for the testing of pre-prototype scale devices	Brian Holmes (IE)
PT62600-202	Scale testing of tidal stream energy systems	Jamie Grimwade (GB)
PT62600-300	Power performance assessment of electricity producing river current energy converters	Sue Malloy (CA)
PT62600-301	River energy resource assessment and characterization	Kevin Haas (US)
AHG 3	Assessment of information received on IEC TS 62600-100, Power performance assessment of electricity producing wave energy converters	Scott Beatty (CA)
AHG 4	Assessment of information received on IEC TS 62600-200, Power performance assessment of electricity producing tidal energy converters	Gabe Alsenas (US)
AHG 5	Assessment of information received on IEC TS 62600-101, Marine energy—Wave, tidal, and other water current converters—Part 101: Wave energy resource assessment and characterization	Matt Folley (GB)
AHG 6	Assessment of information received on IEC TS 62600-10—The Assessment of Mooring Systems for Marine Energy Converters	Ryan Nicoll (CA)
AHG 7	Assessment of information received on IEC TS 62600-201—Marine energy—Wave, tidal, and other water current converters—Part 201: Tidal energy resource assessment and characterisation	Claire Cohen (GB)
AHG 8	Proposal for a plan for the alignment of future work activities under the existing AHGs, PTs, and MTs	Jonathan Colby (US)

Technical Approach and Accomplishments Ocean Energy Systems

- Disseminate information and work products to U.S. stakeholders
- United States serves as operating agent for two Tasks: Task 4 (Annex IV) Pacific Northwest National Laboratory, and Task 5 NREL
- Facilitate information exchange between countries and delegates by:
 - Leveraging information and coordinating efforts to insure that investments are of the highest impact to advance the ocean energy sector
 - Connecting international colleagues with U.S. experts and vice versa
 - Introducing at OES meetings new topics for discussion that can benefit from international collaboration
- Connect U.S. experts with opportunities to participate in international workshops to identify ocean energy knowledge gaps and develop needed work products to fill those gaps



Task 5 Information Exchange Workshops

- Workshop I **“Open Water Testing,”** Ireland, Oct. 2012
- Workshop II **“Computational Modeling & Analysis,”** UK, 25–26 Nov. 2013
- Workshop III **“Designing for Reliability,”** Portugal, 5–6 Feb. 2014
- Workshop IV **“Ocean Energy Policy,”** Sweden, 12 May 2016



Benefit to the Industry: Participation in the OES – IEA Technology Collaboration makes international research results readily available to all of the U.S. industry at no cost and ensures U.S. interests are represented globally. For example:

1. The international environmental research made available in the “State of the Science Report” and Tethys
2. OES Workshops allow immediate collaboration opportunities to participants and provides open workshop reports to all others
3. U.S. participation in OES ensures that U.S. interests are represented in OES international reports and benchmarking activities

Accomplishments and Progress

TC 114

- Five (5) published Technical Specifications in FY14–16 enable industry designs with better design consistency
- 132 active and observing members of the U.S. TAG provide strong input to standards process
- U.S. leadership on TC level (U.S. TAG Technical Advisor and TC114 Chairman) provided critical support of U.S. interests
- U.S. TAG website (www.tc114.us) provides essential dissemination of standards information to stakeholders
- Liaisons to other industry groups provide essential communication
- U.S. leadership under Jonathan Colby recognized with IEC 1906 award for exceptional achievement
- Marine Energy Operational Management Committee (ME OMC) U.S. members help lead certification under IECRE

OES: Open access research and market data is available to all of the U.S. industry, providing international development opportunities



IEC TC114

- U.S. TAG and DOE support initiated in 2008.
- Work is ongoing with no planned end date.
- The standards task has been on track and there have been no significant delays.
- Regular meetings are held for the U.S. TAG, TC 114, and ME OMC.

IEA OES

- U.S. participation initiated in 2005, and Task 4 and 5 started in 2011 and continuing participation is planned dependent on value to United States.
- Four (4) Annex V Workshops have been held and reports have been made public on OES Website www.ocean-energy-systems.org. Future workshops to be held on a rotational basis and organized by selected countries depending on interest.
- The United States will be participating in two new tasks on wave and tidal modeling code validation efforts to be accomplished by subject-matter experts in the member countries.

Regular Go/No-Go decision points for Standards Work are conducted at annual project review meetings with DOE.

Budget History					
FY2014		FY2015		FY2016	
DOE	Cost-Share	DOE	Cost-Share	DOE	Cost-Share
\$765k	—	\$646k	—	\$700k*	—

* \$139,433 transitioned into this in FY16 from a separate Water Power project.

- Project costs have been in line with plans.
- 72% of project funding has been costed to date.
- Projects funds are generally split 80% for IEC TC114 work and 20% for IEA OES work
- NREL provides fixed stipends to supplement work by subject-matter experts (SMEs). Balance of labor is either volunteered by SMEs or provided by their companies.

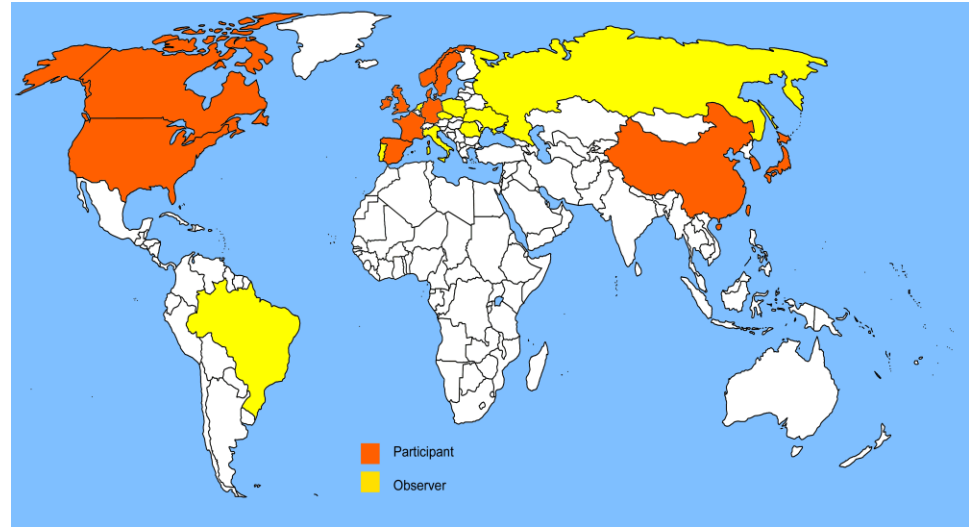
Partners, Subcontractors, and Collaborators

IEC TC114

- Subcontract: Cardinal Engineering.
- 132 U.S. observing and participating members from government, academia, and industry; and 22 member countries.

IEA OES

Member Countries, together with Cardinal Engineering in FY14 and NREL in FY15–16, served as Annex V Operating Agent, in support of DOE.



Participating and Observing IEC TC114 Countries

Communications and Technology Transfer

IEC TC114: The U.S. TAG maintains a website (www.tc114.us) that details the activities of IEC TC114 and provides links to the purchase of all technical specifications.

The TAG TA and TC Chair present the status of TC114 activities at industry conferences and events throughout the year (e.g., METS, OTC, IMREC).

IEA OES: OES reports will be published on the OES website at www.ocean-energy-systems.org when approved by the OES Executive Committee.

FY17/Current Research

IEC TC114: Continue to manage day-to-day operations of U.S. TAG and U.S. participation in IEC. Recruit subject-matter experts for new project teams. Organize and attend U.S. TAG and IEC TC114 Plenary Meetings. Work with Marine Energy Council and DOE to determine prioritization for standards work.

IEA OES: Provide coordination and logistical support; develop technical presentations for Executive Committee meetings and workshops; analyze and review OES reports and work products; and contribute to the OES country report and other OES reports for the United States.

Proposed Future Research

IEC TC114: Standards are evolving over time to identify critical needs of the end users and fill gaps:

- Loads measurement and verification
- Management plan for technology and project development
- Coordinate IECRE activities for certification on Conformity Assessment Board

IEA OES: The OES Executive Committee approved two new tasks to collaboratively validate wave and tidal modeling codes with international experts. Additionally, an international roadmap and strategy are being planned, which the United States will support.